



ADVISORY NOTICE

No. 09-001

SUBJECT: Assessment of Carbon Monoxide Exposures

ISSUED: 6 April 2009

In response to recent inquiries, the Division of EMS has prepared the following guidance on assessment of Carbon Monoxide (CO) poisoning. This information is intended to supplement the current *Rhode Island Prehospital Care Protocols and Standing Orders*. EMTs must be specifically trained in accordance with manufacturers' recommendations on the equipment they will use and are responsible for its proper use.

Overview

Carbon monoxide poisoning is one of the single most common poisoning exposures in the United States. Carbon monoxide, or CO, is an odorless, colorless gas that can cause sudden illness or death. Carbon monoxide is found in combustion fumes, such as those produced by cars and trucks, gasoline engines, camp stoves, lanterns, burning charcoal and wood, gas ranges, heating systems, generators and poorly vented chimneys. Structural fires are another common source of CO exposure for both victims and fire fighters. Carbon monoxide from these sources can build up in enclosed or semi-enclosed spaces. Breathing it can poison people and animals in these spaces. All people and animals are at risk for carbon monoxide poisoning. Certain groups including pregnant women/fetuses, infants, and people with chronic heart disease, anemia, or respiratory problems are more susceptible to its effects.

Mechanism

The unhindered transport of oxygen in the blood stream is critical to the metabolic processes that sustain life. Under normal circumstances, oxygen is transported in the body after binding with hemoglobin to form *oxyhemoglobin* (OHb). However, when carbon monoxide is present in the blood, it will bind much more readily with hemoglobin by a factor of about 200:1, forming *carboxyhemoglobin* (COHb) instead of OHb.

The formation of COHb reduces the blood's oxygen-carrying capacity, impairing tissue perfusion. This situation is described as *CO poisoning*. At high concentrations, the formation of COHb leads to death; at lower concentrations it causes a number of symptoms including fatigue, headache and altered mental status (see below for more detailed list.)

CO poisoning affects several different sites within the body but has its most profound impact on the organs with the highest oxygen requirement (e.g., brain, heart). Misdiagnosis commonly occurs because of the vague and broad spectrum of complaints. Symptoms are often attributed to a viral illness such as influenza.

Recognizing Carbon Monoxide Poisoning

Rhode Island environmental health regulations describe three categories of CO poisoning: *confirmed*, *probable*, and *suspected*. *Confirmed* diagnosis of CO poisoning requires measurement of blood CO levels and is thus not possible in the pre-hospital setting. Instead EMS patients must be screened for *probable* or *suspected* CO poisoning based on their history, presentation, and SpCO readings (if available.) Before diagnosing CO poisoning, consideration should first be given to other common and identifiable causes of similar symptoms (e.g., hypoglycemia or drug overdose.)

A CO-oximeter can be highly useful in assessing potential carbon monoxide poisoning. Unlike a regular pulse-oximeter, the CO-oximeter distinguishes carboxyhemoglobin from oxyhemoglobin, providing reliable readings for both COHb and OHb saturation levels in the blood stream. The saturation of COHb is measured as SpCO. It should be recognized that, like the pulse-oximeter, the CO-oximeter reading is only one element of the diagnostic process; COHb saturation readings must be considered in the context of the patient's clinical presentation and potential exposure history. Thus, the possibility of CO poisoning should be considered for any significantly symptomatic patient, regardless of their SpCO reading.

The following list includes commonly recognized symptoms associated with carbon monoxide poisoning. Any of the following should arouse suspicion if encountered in conjunction with a potential CO source or if more than one patient in a group or household presents concurrently with similar complaints:

General malaise, lethargy	Distractibility, Impulsiveness
Chest pain, heart palpitations	Altered mental status (confusion, hallucination)
Dizziness, weakness	Syncope, seizure, coma
Dyspnea on exertion	Visual disturbances, headache
Nausea, vomiting, diarrhea	Fecal and urinary incontinence
Abdominal pain	Memory and gait disturbances

Additional information sources useful in assessing carbon monoxide exposure include on-site detectors as well as environmental meter readings from fire, hazmat, or utility services. However, it should be noted that there is often no straight correlation between environmental CO levels and the blood CO levels of individuals exposed in that environment. In many cases, the CO source (furnace, etc.) operates intermittently, producing intermittent high CO levels in the environment, while the exposed individual maintains high levels for hours. An exposed individual's blood CO level will remain elevated long after being removed from the hazardous environment. Similarly, substantial variation is often encountered between an individual's blood CO level and their clinical presentation.

Patient Categorization

The Rhode Island Department of Health recommends the following guidelines for categorizing potential CO poisoning victims based on the State's environmental health regulations as well as best practices promulgated in other jurisdictions. For EMS, the focus is on which patients warrant treatment and transport to a hospital emergency department. The distinction between *probable* and *suspect* CO poisoning is relevant primarily as a matter of triage; pre-hospital treatment is essentially the same in both cases.

It should be noted that some individuals will have greater susceptibility to CO poisoning and should be considered particularly "at risk" when being evaluated. Such individuals include: pregnant women, infants or children under the age of 6 years, and individuals with a history of chronic heart disease, anemia, or respiratory problems (e.g., angina, COPD, etc.)

Additionally, consideration should be given to the fact that smokers routinely have elevated baseline blood CO levels. This factor can vary widely from one individual to another; a margin of 4% should be allowed for smokers as reflected in the following guidelines.

Probable Case	Any patient (non-smoker) having a SpCO \geq 9%, regardless of symptoms Any patient (smoker) having a SpCO \geq 12%, regardless of symptoms Any "at-risk" patient (non-smoker) having a SpCO \geq 4%, regardless of symptoms Any "at-risk" patient (smoker) having a SpCO \geq 8%, regardless of symptoms Any patient with CO symptoms and a confirmed environmental source of CO exposure, regardless of SpCO reading
Suspect Case	Any patient with signs/symptoms and history consistent with CO poisoning, with or without a confirmed environmental source of CO exposure

Treatment & Transport

All patients with *probable* or *suspect* CO poisoning should be transported to the nearest appropriate hospital facility based on their presenting signs/symptoms. Any signs or symptoms (e.g., chest pain, altered mental status) should be assessed and treated according to applicable *RI Pre-hospital Care Protocols and Standing Orders*. *Suspected* or *probable* CO poisoning patients should receive oxygen via the highest flow device tolerated.

However, patients suspected of having significant CO poisoning (based on a SpCO greater than 25% and/or presenting severe CO poisoning symptoms) may require treatment in the hyperbaric chamber at Kent Hospital. Before transporting such patients, the medical control physician at Kent Hospital should be consulted by telephone to determine the most appropriate destination – victims of suspected CO poisoning should NOT be automatically transported to Kent Hospital without prior consultation.

Referral

Unless the source of the carbon monoxide was identified, refer all cases of probable or suspect CO poisoning to the local fire department for identification of the source(s) of CO exposure. **NOTE:** For difficult cases in which elevated COHb were documented but no source was found, the RI Energy Office (Dennis Lopes, 401-574-9115) can provide technical assistance to identify whether furnaces, stoves or other appliances are potential/likely sources of exposure.

Conclusion

Carbon monoxide poisoning is a dangerous condition that can be encountered in many environments throughout the year. Though it cannot be definitively diagnosed in the field, it should be considered in when encountering the symptoms described in this Advisory Notice, whether or not there is a readily identifiable source of CO emissions.

Work on these guidelines is ongoing and additional information will be promulgated as it develops. For any questions or concerns regarding identification and treatment of patients with suspected CO poisoning, please contact our physician consultant, Dr. Ken Williams, at kwilliams@lifespan.org or contact the Division of EMS at (401) 222-2401.

REFERENCES

Rhode Island Pre-hospital Care Protocols and Standing Orders. Rhode Island Department of Health, Division of Emergency Medical Services. March, 2008. Available online at http://www.health.ri.gov/hsr/professions/ems/downloads/RIProtocols_Mar08.pdf

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